# Space Weather Technical Forecast

Issued on Tuesday, 01 August 2023 at 13:10 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: R1-R2 Blackouts expected, with a chance of R3. CME arrival expected day 1 (01 Aug) with G1-G2 Minor/Moderate Storm possible.**

**Analysis of Space Weather Activity over past 24 hours**
**Solar Activity:** Moderate with several M-class flares, peaking at M3.6 at 01/0657 UTC from AR3380 in the southwest. There are now eleven sunspot regions on the disc, with AR3380 in the southwest the most notable, having shown significant growth and increased complexity. This is due to flux emergence on its northern periphery, resulting in the development of a strong delta spot. AR3386 persists as a moderately sized region in the north-centre disc, but has been slowly simplifying. AR3392 in the northeast has shown some limited growth, but is not significantly complex. All other regions are small and simple at the present time.
A disappearing solar filament occurred in the centre disc from 31/1800 UTC, near to a C5 flare from AR3380. A CME appeared towards the southwest. In addition there were two filament lift offs from the northeast disc which also gave a CME towards the northeast. Both of these may have an Earth directed component, but assessment is still ongoing.

**Solar Wind / Geomagnetic Activity:** The solar wind at L1, as measured by ACE, was at mostly ambient levels, before a CME arrival started after 01/1100 UTC. Wind speeds varied between 350-430 km/s. Density was average or below, increasing to above average after 01/1030 UTC. The total interplanetary magnetic field strength (Bt) was mostly weak, but jumped to moderate after 01/1100 UTC. The north-south component was also weak but switched from southward to northward directed around 01/0200 UTC. Phi angle remained mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux remained slightly above background levels, but is well below the S1 Minor Storm level. GOES16 high energy (greater than 2MeV) electron flux varied from background to moderate levels at the diurnal maximum, peaking at 935 pfu at 30/1605 UTC. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), with 3.5e7 integrated pfu recorded at 01/0000UTC.

**Four-Day Space Weather Forecast Summary**
**Solar Activity:** Activity is expected to be Moderate, with a chance of rising to High. This is mainly due to the increased potential for M-flares, along with a chance of X-flares, from AR3380 on the southwest disc.

**Solar Wind / Geomagnetic Activity:** An Earth-directed CME has recently arrived. Two further CMEs emerged from the Sun last night, both of which may have an Earth directed component. Assessment is still ongoing, but glancing blows are considered possible on 04 Aug and on 05 Aug. Otherwise solar winds are now slightly enhanced from the CME arrival. Once CME influence recedes on Day 2 (02 Aug), the next enhancement is likely from two further obscured coronal holes either late Day 3 or more likely Day 4 (03-04 Aug), and may coincide with potential CME glancing influence.

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Geomagnetic activity is expected to increase with the first CME to Active to G1/Minor Storm, with a chance of G2/Moderate Storm intervals. These conditions easing during Day 2 to become mostly Quiet to Unsettled. This potentially increasing late Day 3 into Day 4 with coronal hole and CME influence, with a chance of G1/Minor Storm intervals.

**Energetic Particles / Solar Radiation:** High energy (greater than 10MeV) proton flux is now below the S1 level, and is likely to continue easing to background levels. There is a slight chance of a further enhancement to S1 with the CME arrival on Day 1 (01 Aug), before returning to background. There is also a slight chance of further enhancement from any other notable flares that occur, mainly from AR3380. The high energy electron flux (greater than 10 MeV) is likely to drop out with the anticipated CME arrival on Day 1 (01 Aug), before rising again perhaps to High (1000 pfu) levels Day 2 (02 Aug) onward. Any further enhancement Day 3 or 4 (03-04 Aug) will likely lead to a further drop out in values. The associated fluence is most likely to remain below the Active threshold (1e8 total pfu), but with a rising trend from Day 2 once any CME influence subsides.

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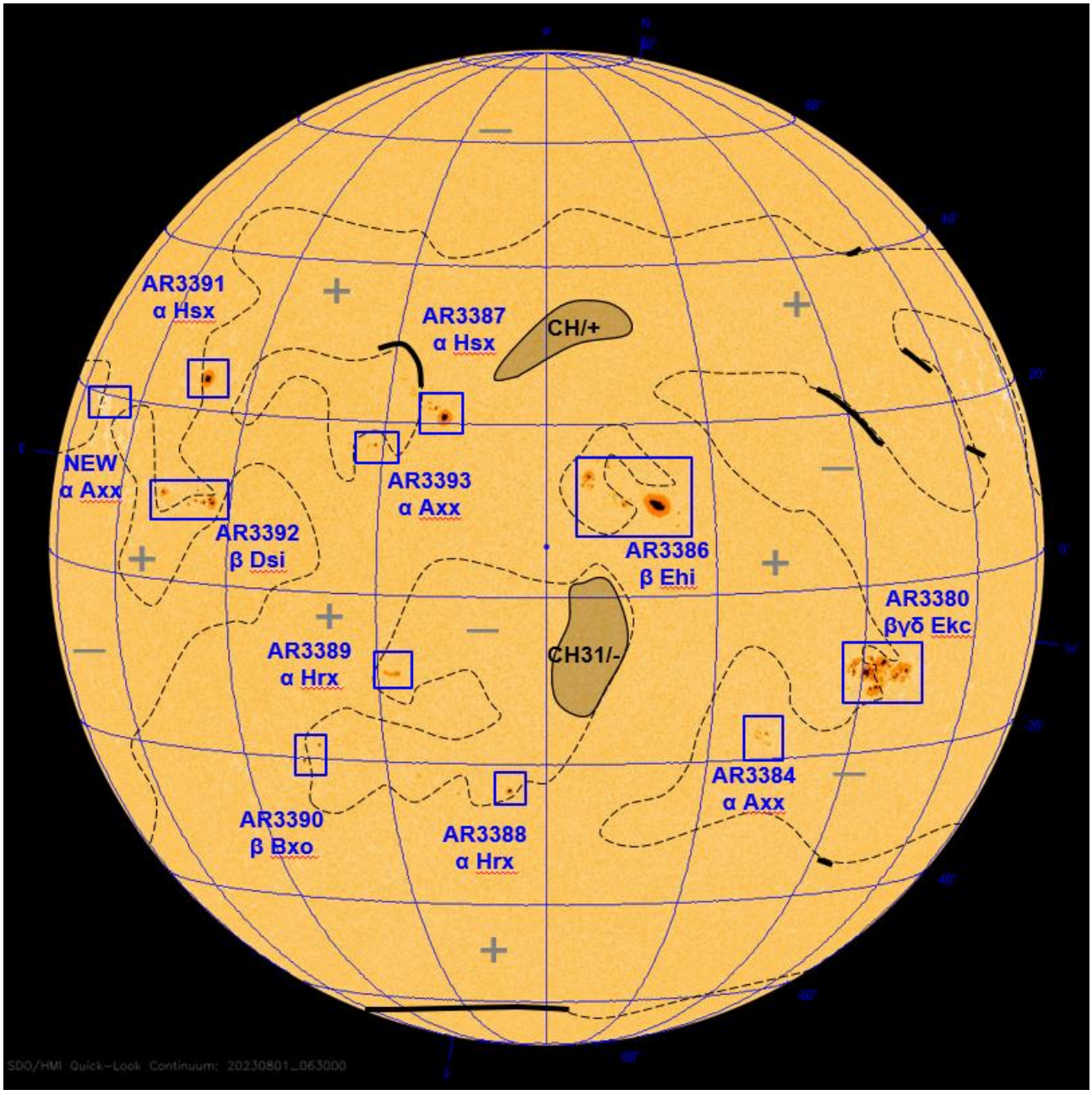
**Figure 1. Solar Analysis Valid 01/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

An Earth-directed CME has recently arrived, due to a filament eruption from the northeast quadrant on 29 Jul. A disappearing solar filament occurred in the centre disc from 31/1800 UTC, alongside a C5 flare from AR3380. A CME appeared towards the southwest. In addition there were two filament lift offs from the northeast disc which also gave a CME towards the northeast. Both of these may have an Earth directed component. Assessment is still ongoing, but a glancing blow from the northeastern CME is considered possible on 04 Aug, with the southwestern CME potentially glancing on 05 Aug.

Otherwise solar winds are now slightly enhanced from the CME arrival. Once CME influence recedes on Day 2 (02 Aug), the next enhancement is likely from either CH31/- or an unnumbered CH/+ in the north-centre disc. Both these features are low confidence however as they are largely obscured in imagery, but are coincident with larger and much clearer coronal holes on the previous 27-day rotation. Any enhancement is expected to be either late Day 3 or more likely Day 4 (03-04 Aug), and may coincide with potential CME glancing influence. Geomagnetic activity is expected to increase with the first CME to Active to G1/Minor Storm, with a chance of G2/Moderate Storm intervals. These conditions easing during Day 2 to become mostly Quiet to Unsettled. This potentially increasing late Day 3 into Day 4 with coronal hole and CME influence, with a chance of G1/Minor Storm intervals.

| Geo-Magnetic Storm | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Minor or Moderate | G1 to G2 | No | 70 | 20 | 5 | 30 |
| Strong | G3 | No | 10 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 01/0701 | Partial | Filament eruption | NE | 599 | 04/0600 UTC | Glancing blow possible |
| 01/0827 | Partial | Filament / flare | SW | 424 | 05/1200 UTC | Glancing blow possible |

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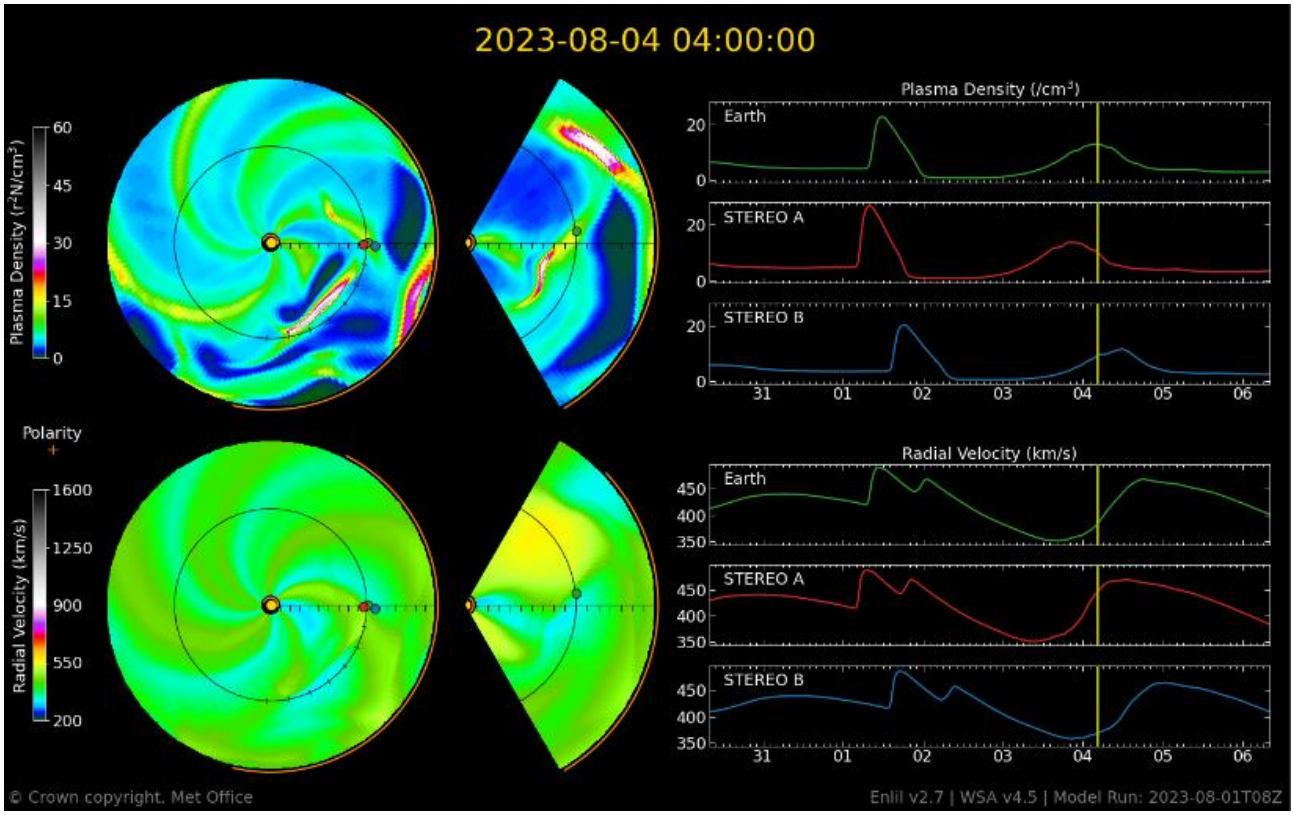
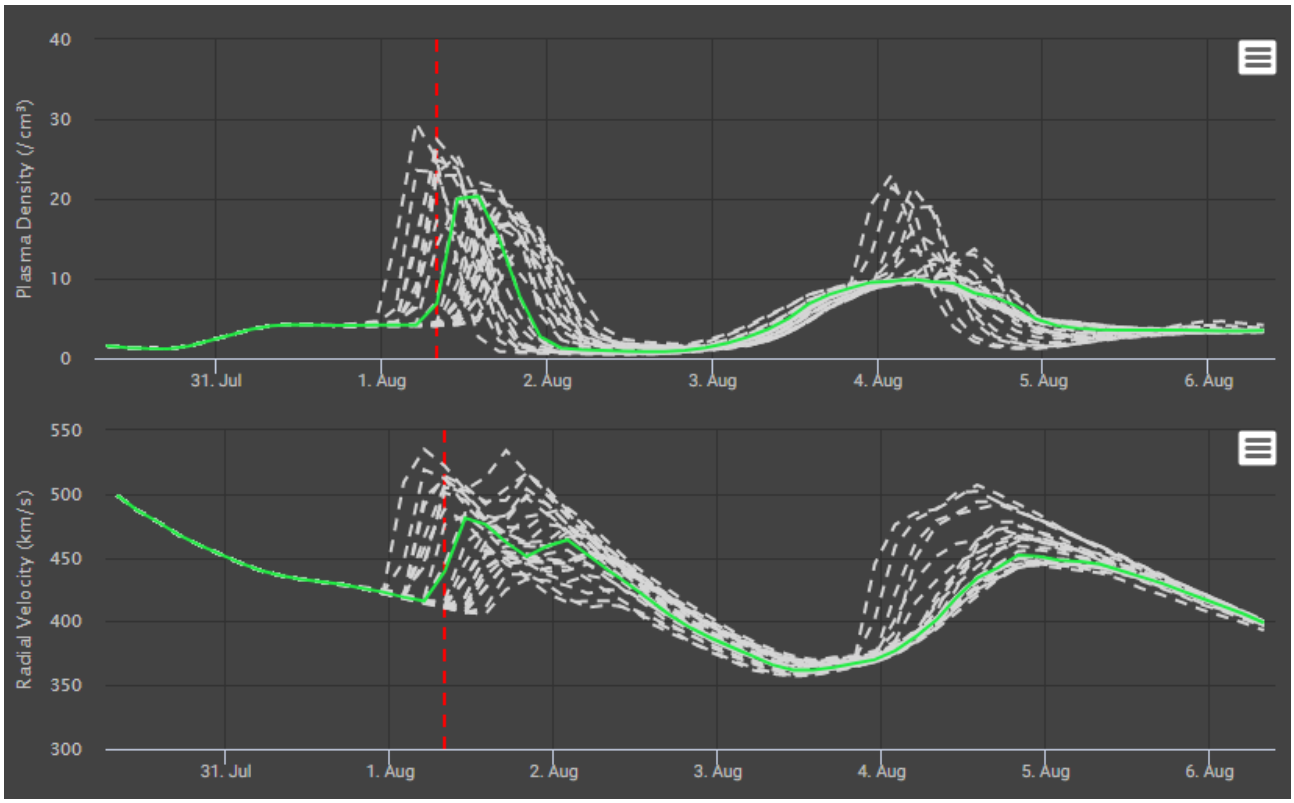
**Figure 2: MOSWOC Enlil and ensemble showing further possible glancing CME blow on 04 August and again on 05 August.**

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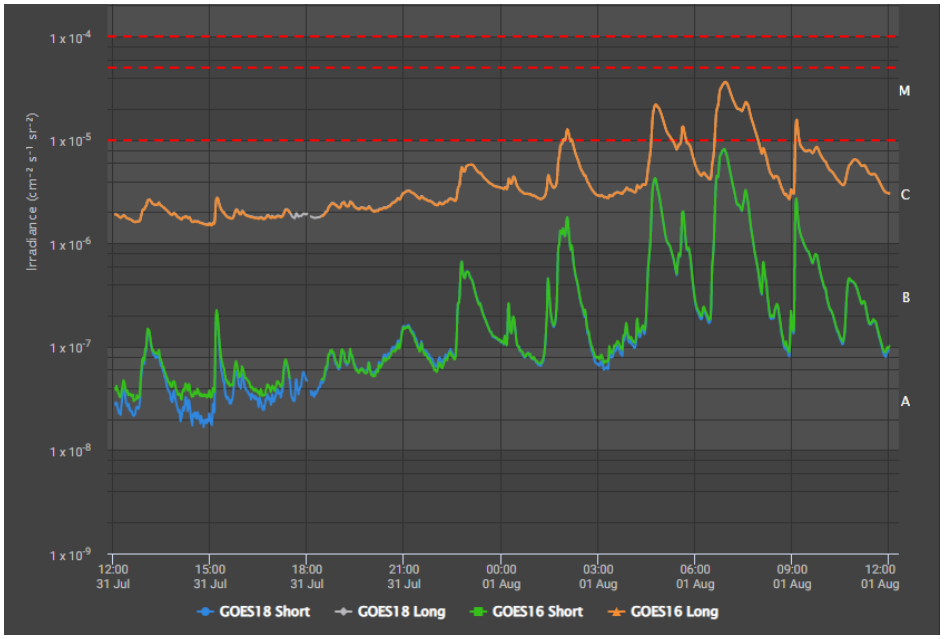
**Radio Blackouts - X-Ray Flares:**
There are currently eleven sunspot regions on the disc with Moderate activity. The most significant region is AR3380 in the southwest. This has shown notable growth on its northern extent, developing into a moderately sized and compact region with a couple of strong delta spots. This looks fairly unstable, and indeed M-flaring from this region has increased in recent hours. Significant flares are possible, with further M-flares expected and a chance of X-flares. Of the other regions on the disc, the only ones of note are the moderately sized AR3386 in the centre north disc, and developing AR3393 in the northwest. The former, however, has remained stable and is starting to simplify. The latter rapidly emerged in the last 24 hours but now appears to have formed into a relatively simple configuration.

There is also the potential for a returning region to rotate onto the southeast limb during day 2 (03 Aug). This would be returning notable region AR3363, and corresponds to a strong signal in far-side products. However there is low confidence for how much activity this region retains from its far-side transit.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Active | R1-R2 M Class | Yes | 80 | 75 | 70 | 70 |
| Very Active | R3 to R5 X Class | No | 25 | 25 | 20 | 20 |

**Figure 3: GOES16 X-ray trace showing recent uptick in flare activity.**

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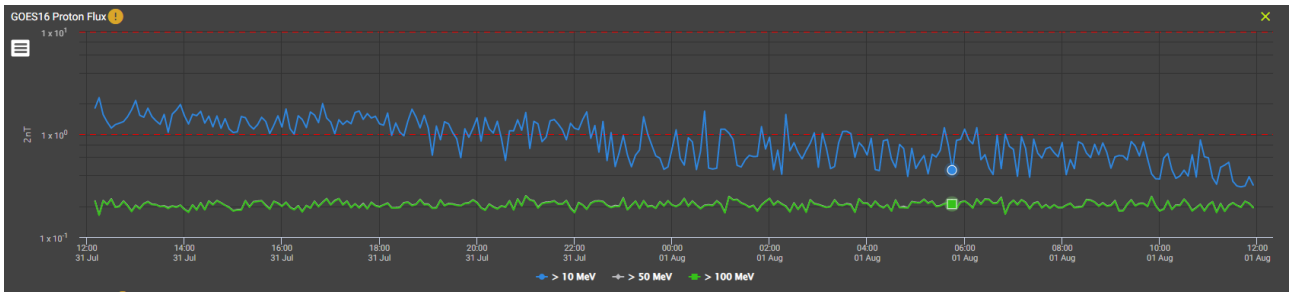
**Solar Radiation Storms - (High Energy Protons):**
The high energy (greater than 10MeV) proton flux is below the S1 Minor Storm level, but currently slightly above background as it recovers from the 28 Jul far-sided eruption that brought an S2 Moderate Storm on 29 Jul.

The CME arrival forecast day 1 (01 Aug) has a slight chance of increasing flux as it arrives, but likely staying below S1. Otherwise the main risk of further proton storms is from the growing and increasingly complex sunspot region AR3380 in the southwest disc. Any significant flares from this region will bring a chance of further increases in proton flux, with a slight chance of exceeding S1/Minor Storm threshold.

| Radiation Storms<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 20 | 15 | 15 | 15 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: GOES16 proton flux, showing a gradual decline to near background levels.**

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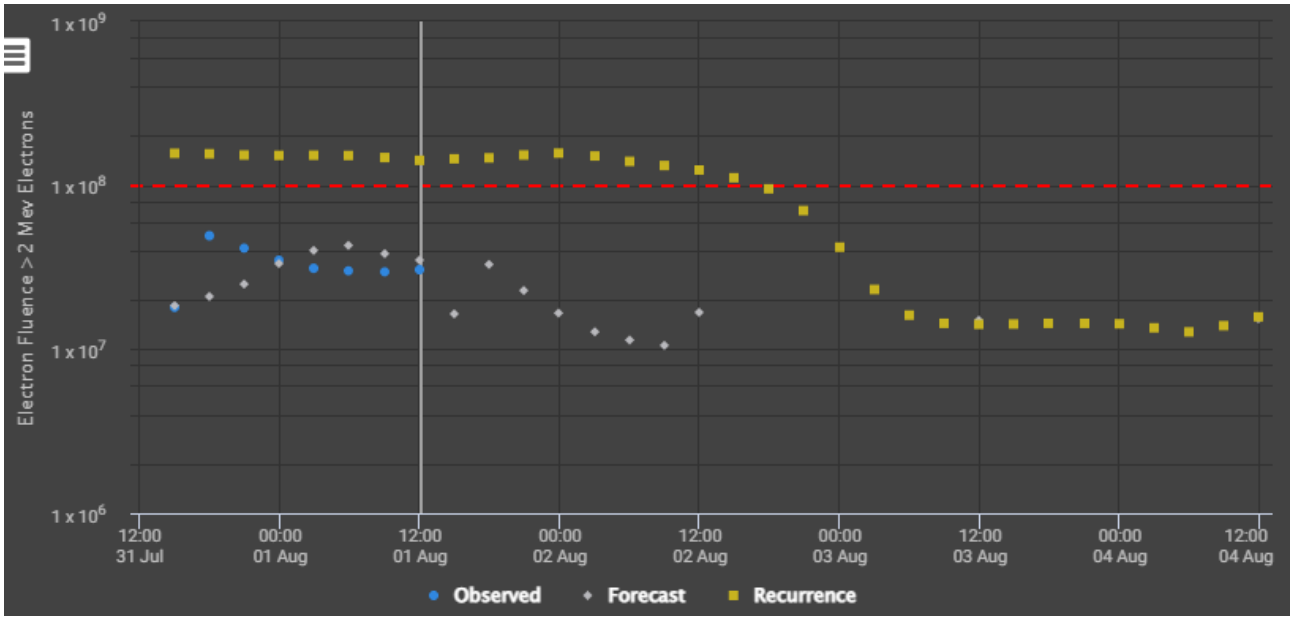
**High Energy Electrons Event (≥ 2MeV):**
High energy (greater than 2 MeV) electron flux observed by GOES-16 is currently background to moderate, and likely to drop out to background at GEO with the CME arrival on Day 1 (01 Aug). As any subsequent solar wind pressure eases during Day 2 (02 Aug) flux observed at this level is expected to rise to Moderate, with a chance of reaching High, mainly at diurnal peak periods. The next drop out of any observed flux is likely to be with a transition into the fast winds either late Day 3 or Day 4 (03-04 Aug), perhaps combined with a further CME glancing blow on Day 4.

The associated 24 hour fluence is forecast to remain below Active (1e8 total pfu) but with a slight chance of rising above, mainly on Day 3 (03 Aug) after the first CME enhancement and before subsequent coronal hole and further CME influence. REFM is currently giving a good guide to background conditions in the absence of any CME arrival, however will become less useful once this occurs on Day 1 (01 Aug).

| GEO Electron Environment | Level ($cm^{-2}\ sr^{-1}\ day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 10 | 20 | 10 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 5: MOSWOC REFM showing a below Active trend. It won't be taking account of any CME activity, however.**

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